PUBLICATIONS

OF THE

AMERICAN ECONOMIC ASSOCIATION.

VOL. V. NOS. 3 AND 4. } { SIX NUMBERS A YEAR. PRICE $4.00 A YEAR.

I.

The Canal and the Railway,

WITH A NOTE ON THE DEVELOPMENT OF RAILWAY PASSENGER TRAFFIC,

BY

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Professor in the Wharton School of Finance and Economy, University of Pennsylvania.

II.

CANALS

AND THEIR

ECONOMIC RELATION TO TRANSPORTATION,

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AMERICAN ECONOMIC ASSOCIATION.

May and July, 1890.

BALTIMORE
FROM THE PRESS OF GUGGENHEIMER, WEIL & CO.
1890.

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LIST OF PRINCIPAL AUTHORITIES.

1. Handbook of Commercial Geography. Chisholm. London, 1889.
2. Schmoller's Jahrbuch für Gesetzgebung, etc., Vol. viii, p. 251 and 751, and Vol. x, p. 1250.
3. Canaux de Navigation—Dictionaire des Finances. Paris, 1886.
4. Navigation Intèrieure—Dictionaire des Commerce. Paris, 1873.
5. House Executive Document No. 79, Vol. xxiii, Second Session Forty-ninth Congress. 1886-7.
6. American Society of Civil Engineers. June 25, 1885.
7. Engineer. 1888. Do. 1889, pp. 59, 109, 153, 181, 195.
8. Society of Arts' Congress. May, 1888.
9. Engineering. August 29, 1884.
10. House Executive Document No. 117, First Session Forty-ninth Congress.
11. Institution of Civil Engineers. Vol. xcvi, p. 195 and foll.; Vol. lxviii, p. 278; Vol. lxxvi, p. 160.
12. Van Nostraud's. Vol. xxix, p. 8; Vol. xxxi, p. 406.
13. Scientific American Supplement. February 1, 1890.
14. Report of Select Committee on Canals. English Parliament, 1883.
15. Le Genie Civil. 1887.
16. Wochenschrift des Oest. Ingeneurvereins. 1888.
17. Annales des Ponts et Chausseés. 1889.
18. Report of British Association for Advancement of Science. Birmingham Meeting.
19. Report of Committee on Railroad Rates. London, 1872.
20. Stahl und Eisen. 1888.
21. Les Annales des Navaux Publics. 1887. p. 1827.
22. Edinburgh Review. July, 1889; do., April, 1887.
23. Spectator. Vol. lxiii, p. 837; Vol. lxi, p. 1284.
24. Nation. Vol. xlix, p. 424.
25. Contemporary Review. Vol. li, p. 71.
26. Murray's Magazine. 1889. p. 185.
27. Railroad Transportation. Fink. Papers published 1874-81.
28. Lehr, Eisenbahntarifwesen. Berlin, 1879.
29. Schreiber, das Tarifwesen der Eisenbahnen. Vienna, 1884.
30. Cohn, der Englische Eisenbahnpolitik. Leipsic, 1883.
31. Transportation Routes to the Sea Board. Washington, 1881.
32. Reports on Internal Commerce of the United States. 1884-87.
33. Railway Problems. J. S. Jeans. London, 1887.
34. Various Congressional Reports on Inter-State Commerce.

THE CANAL AND THE RAILWAY.

There has been of late years a growing and significant revival of interest in the development of artificial water-ways.[1] It would be difficult to assign an exact date for the beginning of the movement, or to say in what country it first started, or even what were the most important causes in producing it. Twenty-five years ago, it is safe to say, interest in canals had almost entirely died out. It was generally accepted as an easy demonstrable truth that the canal had had its day, and those who thought that it might again become an important element in the transportation system of the world were looked upon either as ignoramuses or visionaries.

The opening and phenomenal success of the Suez Canal may be taken, perhaps, as well as any other date to mark the dawn of the new era. Certain it is, at any rate, that from about 1870 to the present time there has been a steady growth in the theoretical and practical attention given to this subject. One begins at that time (and with regularly growing frequency of late years) to find articles on this subject in the periodical literature of the day. It appears more often as a topic of discussion in technical associations. Parliamentary and congressional committees begin to report upon it. Governments make

[1] Compare The Railway Question. By E. J. James. Pub. Am. Econ. Association.

proposals in reference to it. Statistics are collected in regard to it. Legislatures debate various aspects of the problems connected with it. An International Congress has lately been established for the discussion of topics relating to it.[1] And what is more important than all from a practical point of view some important works have been actually carried out, others are under way, and still others are projected.

It is also interesting to note that this revival of interest has occurred in nearly all modern civilized countries at the same time, though in very unequal degrees in different countries. It is quite as noticeable in England as in Germany—in the land where all important means of transportation are in the hands of private parties, as in the land where the railways have for all practicable purposes become government institutions—also in France, where the railways, though chiefly private, are under government supervision, quite as decidedly as in either of the other countries. It is as characteristic of the countries with relatively low rates of transportation by rail as of those with higher rates.

The modern history of canals as an important element in the world's commerce prior to 1870 was much the same in all countries. General attention was first attracted to the enormous possibilities of cheapening inland transportation by the use of artifi-

[1] It is known as the International Inland-Navigation Congress. The idea originated at Bremen in October, 1884, at a meeting of Belgian, German and Dutch engineers, who had assembled to consider the navigable ways and ports of Germany. The first congress was held at Brussels in May, 1885; the second was held at Vienna in June, 1886; the third at Frankfort in August, 1888, and the fourth at Paris in the summer of 1889. It has resulted in bringing to light an immense amount of valuable information.

cial waterways something over a century ago. The Duke of Bridgewater's Canal from Worsley to Manchester, constructed in 1759, and afterward lengthened to Liverpool in 1772, fairly opened the modern era of canal construction—first in England and afterward on the Continent.[1] So great an impetus was given to the industry of the country by the opening up of this canal and the system developed shortly after, that by the end of the century canals became the rage, as railways subsequently. A great canal mania broke out. Numerous schemes were projected and heavy premiums paid for shares. Speculative building of all sorts was indulged in, bringing in the sequel ruin to hundreds and thousands of investors. The canals of that day, however, paid in many cases handsome premiums. The dividends on some of the main lines amounted to 100 per cent. of the capital per year. The shares of the Loughborough Navigation stood at 1,200 per cent.; those of the Mersey

[1] Compare a series of articles on "Canals and Inland Navigation" in the *Engineer* for 1889, by W. H. Wheeler, M. Inst. C. E., to which the writer is much indebted; referred to in this paper as "Canals and Inland Navigation." Mr. Wheeler says of this canal: "The effect of the opening of the Duke of Bridgewater's Canal was not only immediately to reduce the cost of conveying minerals, raw materials, manufactures and produce to one-fourth of what it had been previously, but also by giving facility of transport, enormously to increase the manufacturing industry of the country and the imports and exports from other countries. The greatly increased number of sea-going ships required to accommodate the traffic brought to Liverpool by the canals connected with it raised it to a first class port. The tonnage of English ships increased three-fold, and the number of sailors was doubled. As Liverpool and Manchester owe their first great rise to the Duke's canals, so Leeds may ascribe a great part of its prosperity to the Aire and Calder system. Birmingham would never have developed its hardware trade before the era of railways but for the canals connecting it with Liverpool and the seaports."

and Irwell, the Erewash Canal, etc., at 500 and 600 per cent.

What was done in England was repeated on a smaller scale elsewhere, though before the English example could produce its full effect on the Continent, the war of the French Revolution and the great Napoleonic struggles broke in to prevent any such enormous development as had occurred in England; and before the nations again awoke from the long reaction following the battle of Waterloo, the railway had come to revolutionize the whole conditions of transportation.

If France and Germany lagged somewhat in this race the same could not be said of the United States. The phenomenal success of the Erie Canal, begun in 1817 and finished in 1825, aroused an immense enthusiasm for the construction of similar works throughout the country. The original cost of the canal was $5,700,000. In 1852–3, although the tolls had been reduced to about one-third of the original figures, the revenue was over three million dollars per year. Interest in canals was, as a consequence, everywhere quickened, and up to 1880 nearly 4,500 miles of canal were constructed—by far the largest part of it finished or begun before 1840. The Erie Canal is the largest canal in the world of anything like its importance, being, with its feeders, over 350 miles in length. There were several other long canals, notably the Ohio Canal and feeders, 328; the Miami and Erie, 285; the Illinois and Michigan, 102; the Chesapeake and Ohio, 180; and the Morris Canal, 103—all but one begun before 1830. Adding 411.14 miles of slack water to the canal length, we have 4,879.74 miles of canal and slackwater constructed

in the United States at a cost of $214,041,802, exclusive of the works under the supervision of the general government.

In 1825 the railway era commenced, and slowly at first, then by leaps and bounds, the tonnage of the railways went up, while that of the canals, if it did not go down and disappear altogether, as in many cases, failed at any rate to hold its own against the railway, except in very few cases. So absolute was the victory of the railway that, as said above, the belief became general that the days of the canal were over—an opinion which the railway interests have sedulously fostered.

The cause for the decline of the canal was a complex one—not by any means so simple as it is often represented to be. The fundamental one, of course, is the fact of the indisputable (and from all present indications) permanent superiority of the railway in many of the most essential elements of a desirable means of transportation. This superiority is so manifest that it is almost superfluous to dwell upon it, and yet for the sake of the contrast to be presented later, one or two of its aspects may be mentioned. The most striking point of superiority is, of course, its speed.

The expectations entertained at an early date in regard to the probable speed of railway trains have not even yet been realized in any country. But even if we take the average rate of trains—freight and passenger—to be from twelve to thirty miles, the canal makes a poor showing with its average two to eight miles per hour. The canal exceeded the last figure somewhat in exceptional cases. Thus the trip from Glasgow to Falkirk—thirty miles—was regu-

larly made in 1836 in three hours. On the Ardrossan Canal one horse regularly drew sixty passengers from Glasgow to Paisley in forty-five minutes. The distance from Glasgow to Johnston—twelve miles—was performed in one hour and a half. The rate of speed on the road from Liverpool to Manchester was ten miles per hour.[1]

But even this maximum speed on the canal seems intolerably slow when compared with railroad speeds.

Another circumstance in favor of the railway is the fact that, generally speaking, it can be worked at all seasons of the year and day or night. The disturbances of traffic are, at any rate, in the climate characteristic of the northern temperate zone, only occasional, while the canal is rendered useless by ice for a large percentage of the time. In the eleven years from 1873 to 1883, inclusive, the Erie Canal was closed to navigation for 151 days in each year, on the average, *i. e.*, over forty per cent. of the time. The canal, moreover, under existing conditions and methods of work, is often useless owing to lack of water. As this circumstance usually happens in what would otherwise be a working season it acts still further to diminish the efficiency of the canal.

The fact that the canal is dependent on an adequate supply of water limits, of course, very much the possible routes for canal construction; and as the cost—both in time and labor—of going from level to level is very great, the canal is practically impossible in many places where the railway can easily go. The railway, by throwing off cheap feeders in every direction, can more easily tap an extensive, hilly country than the canal. These cir-

[1] Railways of Scotland. *Murray's Magazine*, 1889, p. 185.

cumstances constitute for the railway a very real superiority under most conditions and for most kinds of traffic.

But great as this superiority is it does not explain of itself the overwhelming victory of the railway at all points. In England one of the circumstances which contributed powerfully to the ultimate victory of the railway was the extraordinary obstinacy with which canal owners clung to their high dividends, refusing to abate one jot or one title of their high tolls, fighting the railways at all possible points, until railway managers saw that they must concentrate their efforts upon breaking down the canal opposition. Even when the canal owners saw the traffic departing from the canal for the railway they still refused to take the only course which lay open to them, viz.: the enlargement and improvement of the canals and the consequent cheapening of the tolls. When once the break was made in the case of a few great lines, and the fact became clear that traffic was being rapidly diverted, canal owners became frightened, and were willing to take what they could get for their property. It became impossible to get capital for the improvement of canals for two reasons: People began to distrust their permanent prosperity, and the railway mania, which was now fairly under way, absorbed all the capital that was to be had.

It is a fact not generally known that a large part of the income from the English canals in the period immediately preceding the railway era was derived from passenger traffic. The passenger traffic on the Glasgow–Falkirk Canal amounted to 300,000 in the year 1836. In this line of business the canal

could not, of course, compete with the railway, and no amount of effort on the part of canal owners could hold this traffic. The rapidity with which it passed away astonished and disheartened canal managers to such an extent as to prevent them from seeing what immense natural advantages they had in the heavier business.

This state of things favored the plans of railway promoters, who saw very quickly that the best thing for them to do was to get hold of the canals and let them go to ruin. Accordingly in all countries they began to acquire the canals. They were most successful in this in England and the United States, where they were able ultimately to get possession, if not of all of them, at least of enough to enable them to control practically the waterways. Thus, in England, Scotland and Wales, in 1880, there were 4,033 miles of canal and canalized river navigation. Of these 1,447 miles were under railway control, of which no less than 948 miles passed into the hands of the railways during the three years (1845–47), when the railway mania was at its height and the fright of canal owners the greatest. Among those under railway control are most of the important lines. It is not necessary, of course, for a railway actually to own an entire canal, or system of canals, in order to control it. All that is needful is that it own or control one part or one link in a chain, since that practically puts the whole line at its mercy. The active warfare of the railway upon the canal goes a long way to explain its decline in the fifty years from 1825 to 1875.

The condition of the canals even in their heyday was such as to make them an easy prey to such a

powerful antagonist as the railway, even if the latter had had no advantages except such as spring from better organization. The system of canals in England (and the same thing was even truer of other countries) was really no system at all. It was an aggregate or a conglomeration of ditches, of no uniform system of construction, of varying depths, of varying widths, belonging to different companies, with different rates of toll, with no system of combined forwarding of goods and no plan of through booking. The individual who wished to ship goods had no means of knowing what it would cost him, and could find no one to become responsible for the goods from the starting point to the close of the journey. The old-fashioned canal had often only two or three feet of water, with locks six or seven feet wide. Now a single stretch of such canal as this in a system or chain, however long, would divide it immediately into two parts, and no matter how excellent the other stretches might be, the capacity of the system of canals was measured by its narrowest and shallowest part.

How impossible it was to readjust this system and organize it efficiently in time to meet the competition of the railway may be seen from the fact that even now, on the main system of canals, there are two or three different gauges of locks; and even where the canals forming a continuous line are approximately of the same size the gauge of the locks is different, being either shorter or having less depth or width.[1]

For example, the line from the coal fields of Derbyshire and Nottinghamshire to London comprises the canals of seven different companies, and has four

[1] Cf. *Canals and Inland Navigation*, p. 109.

different gauges. The locks have an average width of 14 feet 6 inches, but there is one link in the navigation on the Grand Union Canal where the locks are only 7 feet wide, and this limits the carrying power of boats on this line to 24 tons; whereas on other parts of the line the boats can carry from 60 to 80 tons. From London to Liverpool there are four breaks of gauge, the smallest allowing ships of only 30 tons to pass, while the largest permits those of 80 tons. The 30-ton boats that can thus go from London to Liverpool would not be safe for navigating the Mersey, and the cargoes, therefore, would have to be transhipped into larger craft upon arriving at the estuary. These difficulties have put an end to the through traffic that formerly existed along this route.

The Erie Canal has always been able to float larger vessels than its locks would admit. The prism of the canal in 1872, for example, was sufficient to float boats of 650 tons, while some of its locks only admitted boats of 225 tons. The canal at that time could have floated 12,000,000 tons to tide-water, but its locks limited the possible amount to 4,000,000. The cost of freight in boats of 650 tons is only about 50 per cent. of that carried in boats of 225 tons.[1]

To the above circumstances should be added another—the result of the foregoing, it is true, but of powerful reflex influence in delaying the revival of interest in canals—and that is the fact that the railway development not only absorbed public attention completely, commanded absolutely the interest of investors, but as a natural result monopolized almost

[1] Compare Internal Commerce of the United States. Treasury Report, Washington, 1885, p. 426.

as completely the technical ability of the country. Every engineer of any promise saw his hopes of preferment in the railroad. The great fortunes, the great reputations were all made in railroad building or railroad management, and it was accordingly into this career that everybody went who could get a foothold there. The result was just what might have been expected. Improvements in canal building or management stopped. The railway continued to advance. Millions and hundreds of millions of dollars were expended in experiments of all sorts. All kinds of railroads were built into all sorts of places, under all sorts of conditions; the results of experience were carefully collected, and every year, almost, saw some great improvement added to the long line of devices which increased the efficiency of the railway. During all this time —over a generation—the art of canal building and management stood almost absolutely still. It is even to-day the canal of 1825 trying to compete with the railway of 1890. The improvements that might be introduced, the lessons which enable us to build a better canal to-day than sixty years ago, have nearly all been learned in other fields, and are only by accident applicable to the canal, while the improvements in railway making have been largely developed as the result of our experiments in that line.

One point ought to be mentioned in this connection. It would have been impossible to have effected any great improvements in the canal system during the last fifty years without liberal authority from the government to compel the coöperation of existing companies. This authority it would have been im-

possible to get in view of popular indifference and ignorance of the possibilities of cheap transportation by canal on the one hand and the opposition of the railways on the other.

It is no wonder, then, that the canal went down. The undoubted superiority of the railway from many points of view diverted much of the most lucrative traffic from the canal, its striking success from the first, the unbounded confidence of the public in its future, the almost infinite possibilities of investment it offered to the capitalistic public, the enormous profits realized by many promoters and builders, the seemingly infinite field for its expansion, concentrated public attention upon it to the exclusion of its competitor; it absorbed the capital, absorbed the technical talent, and, finally, the canal itself—at least to such an extent as to enable it to control the system as a whole.

What was true of England was also largely true of the United States, and companies and communities not only refused to improve their canals, but they let them run to waste, or worse yet, turned them over to railroad companies, which, in many cases, proceeded to fill them up if they did not decay fast enough by being let alone.

The wonder, then, is not that the canal declined, but that it should show any signs of revivication. Let us turn, then, to the question: Why this revival of interest in this subject? and in the first place, what are the signs of the growing attention paid to the canal and its function in our modern system of transportation?

To begin with Prussia, where the railway system is now practically a government monopoly, the

awakened interest in canal building dates from the early part of the seventies at a time when the railway was still substantially in private hands. But the time of serious activity is to be found after 1880.

The Prussian government laid before the legislature on the 24th of March, 1882, a project for a ship canal from the coal districts of Westphalia to the sea coast at the mouth of the Ems. As the session closed before action could be taken, the plan was again presented at the next session, beginning December 31, 1882.[1]

The proposition was for a canal to be built and operated by the government, and asking for authority to contract a loan of 46,000,000 marks, ($11,500,000) for the purposes of construction. The government, as explained in the project, was simply taking up a plan entertained by Frederick the Great, of connecting this region with the North Sea, a plan which had been warmly advocated by those interested in the Westphalian coal and iron industry since 1857, and approved by the Central Union for the promotion of inland navigation founded in 1869.

The House of Deputies accepted the plan of the government as a whole. As it regarded the project, however, as much too limited in its scope to satisfy the legitimate demands of the present it approved the scheme, adding an additional paragraph to the law authorizing the government "to contract a loan of 46,000,000 marks for the partial construction of a system of canals which should unite the Rhine with

[1] Compare an article on "*Die Frage des Kanalbaues in Preussen*," by Professor Meitzen in Schmoller's *Jahrbuch für Gesetzgebung*, etc., vol. 8, p. 751, from which most of the account in regard to Prussia is taken, cited in the following pages as "*Kanalbau in Preussen*."

the Ems, the Weser and the Elbe, the first link in which should be the line proposed by the government in the project." The House also passed a resolution requesting the government to present a plan of uniting the Westphalian district to the Rhine and Elbe, and of constructing a canal from the mountainous districts of Upper Silesia to Berlin.

The Upper House, after a keen debate on the amended bill, which had been accepted and was then supported by the government, rejected the scheme by a vote of 70 to 65. It immediately passed a resolution, however, by a large majority, requesting the government to present a plan of uniting the eastern and western portions of the monarchy by a network of canals constructed on some uniform system. In view of the plain agreement of legislature and government as to the desirability of developing the present waterways into a comprehensive network of efficient canals, it is plain, says Professor Meitzen, that Prussia stands upon the verge of a fundamental and highly important decision, which, in many respects, resembles that of 1837 concerning the railways.

The systematic plan here foreshadowed has not been fully carried out, but every year sees some substantial improvement in the system of artificial waterways in Prussia, and the other German States are following her example in this respect.

In France the interest has, if anything, been even more marked than in Germany. In 1879 the legislature decided that all the main canal locks throughout the country should be 131 feet in length, 17 feet in width, and have 6½ feet on the sill of the locks, with a clear height of 12 feet under the bridges.

These dimensions allow for the use of barges carrying 250 to 300 tons. To cover the cost of this and other improvements a sum of £40,000,000 ($200,000,000) was voted, and the alterations have been gradually proceeding since.

A glance at a few of the leading canals actually in process of construction at home and abroad may serve to show how active the interest is at present in this subject:[1]

A canal is being cut through the Isthmus of Corinth to unite the waters of the Ægean Sea and the Gulf of Lepanto. It will be about four miles long; was begun in 1882; will be finished in 1892, and its probable cost is about $12,000,000. It will have a surface width of 92 feet, a bottom width of 52 feet, and a depth of 28 feet. It will shorten the voyage from the Adriatic Sea to Turkey about 185 miles.

The North-Sea-Baltic Canal, extending from Brunsbuttel to Kiel, a distance of about sixty miles, was begun in 1887, and is being pushed with remarkable vigor. Its width will be 197 feet at top, 85 feet at bottom, and 28 feet deep, with a possible 29½ feet. The estimated cost is $39,000,000; saving in distance from London to Baltic ports about 250 miles.

The Manchester Ship Canal, intended to make Manchester practically a sea-port, was commenced in the fall of 1887. The plan was prepared in 1882, but it took five years of hard fighting against the combined railroad interests to get parliamentary permission. The canal, counting the tidal division from

[1]Compare Ship Canals in 1889. By R. E. Perry. Transactions of American Society of Civil Engineers.

Easton to Warrington, twenty miles, will be about 35 miles in length. The bottom width will be 100 feet; depth, 26 feet; surface width, 300 feet. The contract price for the work is $30,000,000. It will be seen that the largest ocean freighters can be loaded at the docks in Manchester for India and America.

The Cape Cod Canal, which would shorten the route from Boston to ports South from 70 to 140 miles, has been in process of construction for some time—about two miles of it having been finished to a depth of fifteen feet. The Harlem Canal, connecting East and Hudson rivers, was begun in 1888. The Columbia Canal, intended to give Columbia and the Broad River a water outlet to the sea at Charleston, South Carolina, will be five miles long, 10 feet deep and 150 feet wide at the surface. The most difficult portion of it is already finished. The Nicaragua Canal has been so fully discussed of late years that it is only necessary to mention it. It will shorten the commercial water route of the world from 2,000 to 6,000 miles, and the route from our Eastern to Western sea-boards about 8,000.

Among the projected ship canals, some of which will doubtless be carried out in the near future, should be mentioned—in England, the Birmingham, Great Western, New-Castle-on-Tyne, Scotch and Irish Canals, whose combined results would be to make several inland cities sea-ports, and to cut a way for ships across England, Scotland and Ireland.

On the Continent considerable interest has been manifested in a project for a ship canal from the Bay of Biscay to the Mediterranean, and another to connect the North Sea with the Mediterranean, and one across Italy, and another from the Baltic to the

Black Sea, etc., etc. Brussels will doubtless shortly enlarge her canal to the sea to make it capable of taking in the largest ships.

Among American projects may be mentioned one to secure by a series of canals, beginning with the Cape Cod Canal, an unbroken inland water communication from Boston, New York, Philadelphia, Baltimore, Norfolk to the Carolina sounds. This scheme has important military aspects, and is thoroughly feasible. A project to cut a canal across Florida was started a few years ago, but has not yet got beyond the stage of surveys. A canal across lower Michigan, another across upper Michigan as a complement to St. Mary's Falls Canal and the Michigan Hennepin Canal to connect Lake Michigan with the Mississippi, and a plan for a ship canal from Pittsburg to Lake Erie, are the most important projects which have a prospect of success in the near future.

The proposed canals of an inferior importance for local traffic, and as feeders to rivers, etc., are too numerous to mention, and they are becoming more numerous every decade.

The preceding pages give evidence enough to prove the existence of a growing interest in the canal question. The cause of the revival of interest is as complex as the cause of the decline of the canal in the first place. The prime feature, however, in this revival of interest is the failure of the railroad to realize the expectations entertained of it, as the optimistic faith in its superiority was a prime cause of the decay of the canal. The railroad, in spite of all its improvements, in spite of the enormous reduction in rates for all classes of goods over large

extents of territory, has failed to secure as low rates as the public and shippers, however unreasonably, insist should prevail. The complaints of high charges of transportation are, if anything, keener and more bitter in our own country, where phenomenal rates have been made for heavy long-distance traffic than in any other; and all sorts of experiments in regulation of railroad rates are being tried with little satisfaction to any of the parties concerned—producer, consumer or transporter. Charges of railroad extortion are rife under all systems—American, English, French and German—all testifying to the widespread feeling that railroad rates, for some reason or other, are much higher than is consistent with the public interest.

This feeling was enormously hastened in England by two things: the depression in business following the crisis of 1873, when, owing to the fall of prices and decrease in demand English manufacturers were compelled to canvass carefully all their expenses to see where saving could be made; and when in consequence their eyes were first fairly opened to the enormous rates charged by English railways even on light manufactured goods.

This impression was very much deepened when, as trade began to revive, they found themselves pressed from two directions. Their markets, on the one hand, were cut off by the general reaction in favor of a protective policy in many of the countries where low tariffs had prevailed up to that time, and the consequent increase in competition from domestic producers in those countries put them at a serious disadvantage, notably in the United States. And at the same sime they encountered abroad an active

competition along many lines from the manufacturers of Germany and France in places for which they had been almost the sole purveyors before. The situation called for the most serious consideration, and in the deliberations of all committees on the state of the country, notably in those of the Commission on Depression of Trade, the heavy costs of transportation formed a common subject of complaint.

As the most common answer to this complaint was that the railroads were not making an unreasonable rate of profit, the natural course was to raise the question, is there then a cheaper means of transport than the railway?

From this time on it began to be possible again to get a hearing at the bar of public opinion for the artificial waterway as an element in a transportation system.

The first striking fact that gradually attracted the attention it deserved was the relative cheapness of water as compared with rail traffic. Much as rail rates had gone down, water rates had fallen still faster. The ocean steamer was away ahead of the locomotive and train of cars. The cost of moving freight from the manufacturing districts of England to India in 1889 was 22s. 6d., of which 12s. 6d. was absorbed by the railway carriage of forty miles to the seaboard; *i. e.*, it cost fifty-six per cent. of the whole to go one per cent. of the distance; or to put it another way, it cost 125 times as much per mile by rail as by steamer. If it be said that short distances should not be compared with long, then the rates from Chicago to New York may be compared with the rates from the same place to Liverpool.

The published rates in January, 1884, from Chicago to New York—all rail—were, for grain, 30 cents per 100 pounds; from New York to Liverpool, 10.5 additional; *i. e.*, one-third the price for over three times the distance.

The reduction in freight rates by rail from Chicago to New York from 1868 to 1885 was very large; but that in rates by water was much greater, being a fall of about two-thirds in rail and more than four-fifths in water rates. The freight from Chicago to Buffalo by sail vessels during the season of 1885 for corn was, on the average, a trifle less than two cents. Taking the rate at two cents and the distance as 900 miles, this makes a rate of 0.08 of a cent per ton-mile; the average for steamers was 0.1 cent per ton-mile. The cost per ton-mile on the most favored railroad was at least 0.4 cent, or four times the rate by steamer and five times the rate by sailing vessel. It may be safely affirmed, moreover, that improvements in deep water navigation will keep pace with any possible improvement in railway devices or management; that carriage by water, therefore, will be permanently cheaper per ton-mile than by rail.

But ocean travel would naturally be cheaper, not merely because nothing is received for the roadway, but also because, owing to the depth of water, steamers of any size can be used and any rate of speed mechanically possible can be adopted. The capacity of a ship increases enormously with increasing length, width and depth, and the resistance to a high rate of speed is much less in a wide and open channel than in a narrow passageway. All this, therefore, would throw little light on canal traffic, since the roadway costs much at the beginning and

is expensive to keep in order. The size, moreover, is strictly limited, and therefore the speed must be low, both as a matter of economy in the consumption of fuel and of protection to the sides of the canal, which would be much injured by the wash of a high rate of speed. The results of ocean traffic show, however, the enormous possibilities in the water traffic, and the larger and deeper the canals can be made, the cheaper the cost of movement and the higher the rate of speed.

But a consideration of the actual facts of canal transportation, entirely aside from the possibilities revealed by ocean traffic, opened up a new vista of cheap transportation to a generation which had almost lost sight of a most valuable element in the commercial system of the country. The cost of movement, even on the comparatively inefficient canals, now prevalent is extremely low wherever there is a large traffic.

The average rate charged per bushel of grain from Chicago to New York, lake and canal route, was 4.55 cents compared with 14 cents, the rate by the all-rail route.

As an illustration of actual conditions prevailing in this country, the following instances have been selected: The Guthrie Ice Company was engaged for several years in shipping ice from Willow Springs to Chicago by canal—fourteen miles—and from Summit to Chicago by rail—nine miles. The cost per railroad was 50 cents per ton; by canal, 18 cents, the toll being $5 on each boat carrying 125 tons of ice. The rate per ton-mile on the railroad was 5.55 cents, and on the canal 1.29. The boats were empty one way and the load had to be moved against a cur-

rent of 1¼ miles per hour, in a contracted channel having a cross section of only about three times the area of that presented by the loaded boat.[1]

The Bodenschatz and Earnshaw Stone Company of Chicago gave the rates at the same date—October, 1886—per cord of stone from their quarries in Lemont to the city, as follows; By rail, $4.50; by canal, $1.95. The Excelsior Stone Company gave the rate as $3.90 and $1.73 respectively. Coal is carried from Erie to Chicago, nearly 1,000 miles, for 64 cents a ton; thence to the Mississippi River by rail, 200 miles, the cost is $2, and for the next 100 miles it mounts up to $4.

With enlarged canals, constructed on a uniform system, the cost of movement becomes, of course, proportionately less. The original Erie Canal quickly became too small for the traffic, and it was resolved to enlarge it. The improved canal could take boats of 225 tons as compared with 75 tons in the old canal. The greatest size of the old boats was 78½x14½x3½, compared with 98x17½x6½. The length was increased one-fourth, the width one-fifth, and depth nearly doubled, while the carrying capacity of the boat was trebled. The engineers foretold a saving of 50 per cent.; figures showed subsequently that it somewhat exceeded this figure. A similar enlargement now would bring about a similar reduction in cost of transportation.

Another result of the consideration given to the question has been a revelation of the importance still possessed by existing waterways with all their drawbacks. Mr. Marshall Stevens, in a paper before the British Association for the Advancement of Sci-

[1] Compare House Executive Documents, 1886-87, Vol. 23, p. 45.

ence, in their session at Birmingham, states that more fine goods are carried between Manchester and Liverpool upon the Bridgewater Canal than upon the lines of any of the three competing railways, notwithstanding that the rate by water is the same as by rail. The tonnage on the canal amounts to 60,000 tons per mile per year. On the Birmingham Canal, during the recent depressed condition of trade, 7,000,000 tons of goods passed over it in one year. The Weaver has 265 vessels trading on the river, of which 65 are steamers carrying a tonnage of 1,300,000 tons a year in addition to the ordinary canal boats. The whole of the salt taken to Liverpool for shipment, amounting to 800,000 tons, is carried down the Weaver, none being taken by railway. The tonnage carried on the Trent and Mersey Canal, notwithstanding the great number of railways with which it has to compete throughout the whole district which it traverses, amounts to over one and one-quarter million tons a year.

In France the tonnage on the canals and navigable rivers amounts to 19,573,263 tons a year. About one and three-quarter million tons of coal are carried from Belgium to Paris by water. On the canalized port of the Seine the freight carried amounts to nearly three million tons.[1] During the year 1885 the traffic by water to Paris amounted to 4,749,270 tons, carried in 33,878 boats. Of the whole amount of merchandise brought to Paris, 38 per cent. came by water and 62 per cent. by railroad. There are in France nearly 4,660 kilometers of canals in operation. Many of these are so small or extend into regions where there is so little traffic, that they

[1] See *Canals and Inland Navigation*, p. 282.

are insignificant in the commercial system as a whole. The tonnage upon rivers and streams was in 1885, 8,936,291 tons; that on canals, 11,135,166 tons; total, 19,573,263. There were only six canals with over half a million tonnage for that year.[1]

There is a very marked tendency of late years to lengthen the average run per ton on the canals, showing the effect of the late improvements. It is interesting to note the classes of goods transported on the canals and rivers. The following table shows the facts for 1885:

	Tons.
1. Combustible materials	5,436,212
2. Building materials	6,420,537
3. Wood and lumber	1,392,703
4. Mining industry	1,285,687
5. Agricultural products	2,482,998
6. Manufactured products	589,262

The importance of the canal is not less in Germany. The relative tonnage of the canals decreased up to 1870 in Germany as elsewhere, but since that time they have not lost ground, but rather gained, and along many of the chief lines they have gained considerably. The tonnage arriving and departing by water rose from an average of 12,749,000 in the forties to an average of 33,337,000 in the seventies, rising to 37,954,000 in 1881. The size of the ships increased from 470 to 888, while the number rose from 48,000 to 71,000 in the period from 1845 to 1875. Of the cargoes in 1881, 60 per cent. consisted of stone, 12 per cent. of lumber, 13.3 per cent. of fuel, 8.5 per cent. of provisions and 5.8 of "store goods." In 1840 the fuel made out 40 per cent. of the whole. As a rule the heavier material shows a

[1] See Block's *Annuaire de L'Economie Politique* for 1888, p. 540, and following.

tendency to seek the canal. The great exception to this is coal.[1]

There is a good reason, of course, for this. Coal as a great article of transport in Germany, is of very recent date. The canal system was constructed with reference to another industrial condition. It does not reach into the coal regions, therefore, except accidentally, while the railway owes a large part of its rapid growth to the transport of coal. Besides this, as the great coal regions in Germany are hilly, the cost of making canals through such districts is, of course, relatively high.

The extent to which the canal has managed to hold its own even against the improved and improving railway can be seen from the percentage of the total traffic in Berlin, which is water traffic. In 1869 56.2 per cent. of the total traffic came and went by water; and even as late as 1872 50 per cent. was water traffic. In 1878 the proportion had sunk to 37.8 per cent. All this in spite of the fact that much has been done in Berlin to discourage the water traffic in the last few years. The number of waterways has not been increased of late years at all, being limited to four; while the number of railroads, which was five in 1867, has been increased to eleven. Almost nothing had been done in the way of improving the canals, either by deepening or widening, or providing more loading places, or in any other respect. In 1880 the proportion of grain transported by the canals stood to that transported by rail as 26:29; wood for fuel, as 30:1; flour, as 1:2; stove-coal, as 7:18; stone, almost all by water.

[1] Cf. Der Wettstreit zwischen Wasserstrassen und Eisenbahnen in Deutschland. Schmoller's Jahrbuch, Vol. viii., p. 251 and following.

In 1887 the waterways had again overtaken the railways in the proportion of 49:45, *i. e.*, a little over 52 per cent. of the traffic was by water—surely a fine record when one considers the enormous improvements in the German railway system in the last twelve years.[1]

Along the Rhine and Elbe water traffic has not only held its own, but in some cases even exceeded in its growth that of the railways. This is to be ascribed chiefly to the fact that of late years the system of tug-boats and cable-boats has been introduced very largely. The navigation of the Elbe has increased of late years in a remarkable manner, partly as the consequence of cheaper freight rates and partly as a consequence of the introduction of rapid and regular trips along the river in both directions. This was possible only as a result of the late improvement of the river by the great works undertaken and carried out by the government. The following table shows how rapidly the water traffic has increased at Hamburg:

YEAR.	YEARLY INTERNAL TRAFFIC.		Proportion of Railroad to Water Traffic.
	On the Railroad. Metric hundred wt.	On the Elbe. Metric hundred wt.	
1871–1875	5,412,000	3,274,000	100 to 60.2
1876–1880	11,118,000	6,246,000	100 to 56.4
1879	11,203,000	7,053,000	100 to 62.8
1880	12,896,000	8,245,000	100 to 64
1881	12,765,000	9,266,000	100 to 72.5

[1] Statistisches Jahrbuch der Stadt Berlin. R. Boeck, Berlin, 1889.

When it is considered that this represents the total traffic, and that it is simply one waterway against all the railways—many of which, owing to their position, cannot be considered competing routes—one can see how vigorously the canal and river can compete with the railway. An interesting feature about it is that much of the lighter traffic now uses the river instead of the railway. The value of the commodities transported by rail stood to that of those transported by water in 1879 as 100 to 22.7, 1880 as 100 to 26.5, 1881 as 100 to 33.4. The relative number of steamers on the river rose from 10.3 per cent. in 1860 to 28 per cent. in 1880. The average tonnage of the boats rose from 809 to 1,263 metric hundred weight in fifteen years.

The relative growth of river traffic appears in a striking light when compared with the total traffic—railroad and ocean—which has its center at Hamburg. From 1851 to 1860 there arrived annually at Hamburg, by way of the River Elbe, 4,383 boats, with a tonnage of 411,659; in 1887 over eleven thousand arrived, with a tonnage of over 2,000,000, *i. e.*, the traffic increased in twenty-seven years five-fold. In the fifteen years from 1871 to 1886 the percentage of river traffic as compared with total traffic rose from 9 per cent. to 18 per cent., showing a decidedly greater increase of river traffic than of ocean or railroad.[1]

Similar phenomena meet us on the Rhine. The reports of the Chamber of Commerce at Mannheim

[1] Compare Schmoller's Jahrbuch for 1889, p. 376.

contain some interesting results, summarized in the following table:

AVERAGE FOR YEARS 1875 TO 1881.

WARES.	METRIC HUNDRED WTS.		Per cent. by water.	Per cent. by water at beginning and close of period	
	By Rail.	By Water.		1875.	1881.
Flour	141,000	48,000	25	4	35
Coffee	85,000	107,000	56	41	71
Salt	19,000	334,000	95	89	98
Soda	58,000	26,000	32	23	56
Petroleum	138,000	117,000	46	21	61
Coal	2,404,000	3,354,000	58	50	69
Stone	399,000	244,000	38	19	50

The average, according to value of twenty-five leading articles, rose from 54.5 per cent. to 66 per cent. in the same period, the average for the seven years being 59 per cent.

Mannheim, although an inland city and one of the greatest railroad centres of Germany, had in 1881 a water traffic exceeding the rail traffic by nearly one-half.

The enormous improvements in the inland navigation of Germany have attracted the attention of foreign engineers. Mr. L. F. Vernon-Harcourt, member of English institution of Civil Engineers, attended the Congress on Inland Navigation at Frankfort in 1888. On his return he gave to the Institution of Civil Engineers an account of some things he had seen. At Frankfort itself he found a river traffic of nearly half a million tons in 1888,

which was only 10,000 three or four years before, the river having been improved in the meantime. Of Mannheim he says that the traffic rose from 583,000 tons in 1876 to 1,796,000 tons in 1886, the joint trade of Mannheim and of the port immediately opposite across the Rhine being 2,443,000 tons. The prosperity of Mannheim, he says, exemplifies in a remarkable manner the advantages of extending deep water communication as far into the interior of a country as practicable; and the rapid growth of the river traffic, both at Mannheim and Frankfort, indicate the important position held by those ports which are situated at the extreme limit of large navigations.[1]

The importance of the canal as measured by its tonnage is not as great in the United States as in England or France or Germany. This might be naturally expected owing to the fact that there has been a greater development of the railway on the one hand and almost no development of the canal for fifty years on the other. But even here the tonnage of canals, though insignificant in comparison with the railway, reached the handsome figure of over 20,000,000 tons in 1880.

The Erie Canal is even now, after all development of railway lines and in spite of the fact that the State has allowed it at many points to fall into such a condition as to seriously impede traffic, no mean element in the transportation system of New York and of the country at large. As late as 1884 the Erie Canal took half as much grain to New York as all the trunk lines combined, though it is closed for five months in the year.

[1] Minutes of Proceedings of Institution of Civil Engineers, vol xcvi, p. 200.

The importance of a canal to serve as a connecting link between two great systems of water transportation has no better exemplification than the history of the St. Mary's Falls Canal between Lakes Superior and Huron. Opened in 1855, its tonnage began to grow immediately, doubled in three years, doubled again in the next five, more than doubled again in the next ten years, doubled still again in the next ten, doubled again in the next four, nearly doubled again in the next three years. The tonnage has grown as rapidly as the facilities for handling it. It rose from 101,458, registered tonnage, in 1856, to 7,221,935. The actual tonnage exceeded the last amount by nearly 300,000 tons, or an increase of 7,200 per cent. in 33 years. The number of passengers rose from 4,260 to 25,712, though the highest number was attained in 1884, with over 54,000 passengers. When we consider that the canal was only open 234 days, the immensity of the traffic can be better appreciated. The number of vessels passed through in 1889 was 9,579 compared with 1,091 in 1878. Of these, in 1889, 6,507 were steamers. The value of the traffic passing through rose from $53,413,472 in 1875 to $83,733,527 in 1889.

Its relative importance may be seen by comparing its traffic with the Suez Canal. The tonnage passed through the latter in 1887 was 5,903,024, or only a little over 80 per cent. of that passing through the St. Mary's Falls in 1889. The ships passing through the Suez Canal are, of course, much larger, and as the canal is open all the year, the number passed through the canal per day is much larger in the St. Mary's Falls. The daily tonnage for 1887 was 18,937 tons, compared with 15,802 in the Suez Canal.

The total tonnage of vessels engaged in the foreign trade—both American and foreign—entering the port of New York in 1887 was 6,074,543 tons, or only 84 per cent. of that passing from Lake Huron to Lake Superior. The estimated saving in freights achieved by this canal, as compared with railroad rates for similar services, is over $300,000,000.

The Illinois and Michigan Canal, though little more than a ditch, transported nearly 5,000,000 tons of freight during the five years ending in 1885. As this would be a canal of the same general character as the Erie and St. Mary's Falls, *i. e.*, one forming a connecting link between two great systems of transportation, there is little doubt that if it were made a ship canal it would develop an enormous traffic.

The total mileage of railway operated in Pennsylvania for 1888 was 10,802. The total tonnage was 235,145,608, or an average of about 22,000 tons per mile. The total canal mileage was 778, the total tonnage being 7,574,726 tons, or an average of nearly 10,000 tons—this in spite of what one might call a systematic purpose to ruin the canals.

Still another result of the recent consideration given to the canal question has been a recognition of the importance of the canal as a means of regulating railway tariffs. In this respect the experience of the United States has been more important than that of any other country. It is generally agreed by all railway authorities that the only efficient controller of railway rates is the waterways. No efficient control could have been exerted in this direction if it had not been for the Erie Canal. This channel, connecting, as it does, with the ocean, the system

of waterways united with the Great Lakes, exercises a controlling influence on rates over the whole Northern and Western, and even Southern sections of the country. A recent article in the New York *Evening Post* emphasizes the influence exerted in this respect by our great waterways. "Grain may be carried by lake and canal to New York, by coastwise steamer to Savannah, and thence by rail back to Atlanta, Ga. Thus the rate which can be charged from Chicago direct to Atlanta by rail is limited by the Erie Canal. In truth, there is not a city east of the Mississippi whose rates are not affected by the canal directly or indirectly. The statement that the grain valley of the Mississippi has no natural connection with the Atlantic seaboard is not commercially correct. The Mississippi River, however, is to-day as great a factor in our export trade as though it were crowded with fleets of boats carrying grain to New Orleans. A single boat to the Gulf from St. Louis, if it could carry grain at a rate less than the European rates to the Atlantic coast, would cause a readjustment of east-bound tariffs. Quantity cuts no figure in such a case; the potentiality is enough."

Mr. Albert Fink, one of the ablest railroad managers in the country, has testified on more than one occasion to the far-reaching influence of the Erie Canal on railroad tariffs in the United States. In a letter to Senator Windom in 1878, he expresses himself as follows:

"You are aware, sir, that when the rates are reduced between Chicago and New York, as they are always reduced on account of the opening of the canal, that this reduction applies not only from Chicago, but from all interior cities (St. Louis,

Indianapolis, Cincinnati) to New York. If that were not the rule the result would be that the roads running from those points to Chicago would carry the freight to Chicago from which low water or rail rates would take it to New York and thus leave the through lines from the inland cities without traffic. Hence, Philadelphia, Baltimore and Boston, though they have no direct water competition, get the advantage of reduced rates. The reduction of rates from Chicago and St. Louis to New York, Philadelphia, Baltimore, etc., reduces rates on shipments from those Western points *via* New York and the ocean to Southern Atlantic ports, Norfolk, Wilmington, etc., and from there into the interior, Augusta, Macon, etc. The direct railroads must reduce their rates correspondingly, and thus the Erie Canal determines rates all over the country, including the South, until it reaches a line where low ocean rates from New York to the Gulf cities exercise their influence upon the rates to adjacent interior points."

Other distinguished authorities have maintained that if the Erie Canal did not carry one ton of freight it would be well worth keeping up simply as a regulator of railway rates.

The St. Mary's Falls Canal makes it possible to ship by water from all lake points to Duluth, which is an outlet for the great Northwest. Railroad rates over hundreds of thousands of square miles are now far lower than they would be without the direct and indirect influence of this great waterway.

But even smaller canals have exercised a no less important influence considering their circumstances.

Prominent among them may be mentioned the Illinois and Hennepin Canal—little more than a ditch—which is paralleled throughout almost its entire length by the Chicago, Rock Island and Pacific Railroad. Wherever they touch the same point railroad rates follow canal rates. Thus, from Henry to Chicago—100 miles—the rate is 8 cents per 100 pounds. From Tiskilwa—twelve miles further west but beyond the reach of direct water competition—the rate is 15 cents, or nearly twice as much for twelve miles as for the next hundred.

A striking illustration of the effects of facilities for water transportation on industry is afforded by the history of the Great Kanawah River Improvement. The Great Kanawah Valley, although one of the richest coal districts in the country, had to wait for river improvements before its industries could be adequately developed. The total shipments of coal for the years 1883 to 1887 were in round numbers twenty-nine, thirty, thirty-two and forty-two million bushels. Of these fifteen, eighteen, nineteen and twenty-three million bushels were shipped by river. Most of the coal shipped by rail was intended for points lying beyond the reach of the water route competition. Where it went to lower cities on the Ohio than Cincinnati the rates had to readjust themselves to water rates. The history of this valley showed the reluctance of capital to go to places where it would be cut off entirely from the possibilty of water transportation. It shows also how rapidly railroad transportation may grow as the result of a development which would not have been possible without the canal.

We may sum up, then, the result of recent investigation and experience in relation to the canal in the following propositions:

A modernized canal may perform a valuable function in our system of transportation.

In the first place, because it can carry certain kinds of freight more cheaply and more satisfactorily than the railway. Heavy, bulky goods, which do not deteriorate in the time required for transportation by canal can be moved much more cheaply by canal than rail wherever a large traffic exists. This is so amply shown in the preceding pages to be the opinion of competent engineers in all countries that we need not develop the point further here. Again, certain kinds of goods can be carried more satisfactorily by water than by rail, such as worked marble and other commodities which suffer from the jars incident to the smoothest railways.

Such a saving in transportation as may be effected by the canal is of great importance on its own account, as it would render possible the cheaper production of many commodities. But it would be of immensely more value because of the new industries which it would thereby develop. The country is full of immense stores of natural wealth which is only waiting for the possibility of cheap movement to make as great a change in our industry and commerce as was effected by the railway itself. There is no sign that the railway will ever overtake the canal in its possibilities in this respect since improvements in cheapening carriage by water keep full pace with, if they do not exceed, those in rail transportation.

This fact reveals how the canal, far from being a mere competitor of the railway for the traffic nat-

urally most suited to it, is a valuable accessory since by its ability to call into existence new industries whose product would be carried by railways, it can so promote the progress of industry as to increase almost indefinitely the traffic both of itself and of the railway. Experience has shown in more than one case that the railways running right along the length of large canals found their traffic increase as that on the canals increased. The railways along the Erie Canal form classic illustrations of this fact. The instance of the railways running along the Main in Germany, the Rock Island and Pacific in this country along the Hennepin Canal, and many others, might be cited.

The article above mentioned in the *Evening Post*, evidently written by a careful observer, also calls attention to this fact: "The effect of natural and artificial waterways upon railways is usually considered by railway managers to be detrimental, and they have put forth every effort, both in England and here, to control or close all canals. But is this true policy? At first, no doubt, the railroad loses much of its heavy traffic which very likely it has been carrying at comparatively high rates. Some of this loss must be permanent. Very soon the prosperity and growth of the city demands quick transportation, at profitable rates, of manufactured goods and supplies. This is supplemented also by a certain proportion of the heavy traffic, in spite of the canal. The final result is a large traffic; possibly at lower average rates, but yielding fair returns. The railroad has in the end reaped part of the advantage which cheap water transportation gave to the city served by both. The Lake Shore is benefited by the

prosperity of Cleveland and Buffalo, while the New York Central, following the Erie Canal its whole length and forced to conform its real (though not always its nominal) charges to canal competition, finds a succession of flourishing towns and cities whose traffic is the envy of less fortunate roads."

This point has been so fully developed in many able papers by Professor Haupt, of the University of Pennsylvania, that it is not necessary to go into it any further.

But the canal is also valuable in still another way than that indicated above. By taking from the railway certain heavy traffic which costs much to move in time and wear and tear, it frees the railway from a kind of load which interferes seriously with its performance of the sort of work for which it is, technically speaking, best fitted, viz.: That in which speed is the most fundamental requirement. No one who studies the problems of modern society, can doubt that passenger traffic, for example, can be enormously increased, if only cheap and fair transportation can be furnished. The experience of European roads in this direction, working among a people immensely harder to set in motion than our own, gives striking evidence of this fact. Our American railways have done next to nothing to develop systematically the great possibilities of our country in this respect; and one of the reasons is to be found in the fact that the heavy, slow traffic they most rely upon under our present system, interferes so seriously with the fast trains that the latter cannot be put on in the number or quantity necessary to develop the possibilities of this line of traffic. It is a common thing for railroad managers in this country, as well as

elsewhere, to say that they care little for the passenger traffic, they gain nothing from it, etc., when the simple fact is that they have deliberately adopted a policy of reaching out for freight traffic of a kind unsuited to them in such a way as to prevent them from making any fair test of the profit which lies in passenger traffic.[1]

A writer in the *Edinburgh Review* of July, 1889, uses strong language in regard to the policy of the English railroads, which in this respect is very similar to that of our own. "In 1845," he says, "the railways departed from their old policy of developing new traffic and began to compete with the canal. In 1848 they bought four canals, in 1846, sixteen.

"For the principle of free traffic, of providing trains as the public filled them and allowing coach, wagon and canal-boat to take such custom as adhered to the old routes, thus providing a sort of automatic filter, admitting none but a lucrative traffic, was substituted the false energy of competition—competition not with the road alone, but between road and parallel lines, and competition with the cheap and useful water carriage of goods that could not afford to pay for rapid transport, by systematic obstruction of those waterways to which England owes so much of her manufacturing and productive wealth. The country has never recovered from this fatal mistake. Inter-railway competition would probably have been but a temporary mischief. But defiance of mechanical law, in forcing on the rail, traffic which could

[1] In a paper read in April of the present year before the AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE at Philadelphia, the author presented a brief review of the result of the Hungarian experiment in developing passenger traffic, which will be found in abstract at the end of this article.

far more cheaply be conveyed by water, has proved a millstone round the necks of English railway proprietors from 1846 to the present day. A mine of wealth lies open to English railway shareholders if their directors and managers will only return to the sound and remunerative policy that produced so steady an increase of percentage on capital down to the year 1844. That policy consisted in providing road and transport for such traffic as sought the railway (without making any efforts of an aggressive nature to drive traffic either from the highways or waterways), and in refusing to carry heavy and low-priced articles of transport at freights which are a robbery of the shareholders."

This is strong language, but not too strong, and applies as fully in this country as in England. Railroad managers, however, are really not to blame for it, since by the very nature of the case they must live more or less from hand to mouth. Each one must look out for his own road, must adapt himself to given conditions. He is naturally more interested in getting the largest earnings for his road during the time of his management than in trying to realize such conditions as will develop a greater traffic in the long run for railroads in general.

It is the general public, the people who are supposed to be the guardians of its interests, its statesmen, law-givers, politicians, editors, etc., who have shown themselves to be lacking in wisdom or probity, and have permitted railroad managers to make their own conditions of competition instead of keeping open the waterways and compelling railway managers to adapt themselves, as they easily could have done, to such conditions as would have secured

in the long run not only the interests of the great public, but even those of the railways themselves.

Take another instance of traffic waiting on the railways. There is an immense business in the line of perishable commodities, lying almost absolutely undeveloped because the railways cannot adjust their business so as to meet the demands of the case. Fresh fruit, milk, meat, vegetables, etc., are the commodities many of our railroads should be carrying instead of stone, iron and coal.

The canal, then, saves cost of transportation, relieves the railway of its most costly and embarrassing traffic, and develops a supplementary traffic which increases railroad business. It does still more. It acts as an automatic regulator of railway tariffs—a most important function in these days, and in such a country as ours, where everything is tending toward consolidation and combination—but no less important in a country like Germany, where the railways have passed practically into the hands of the government, and thus the feeble check on rates is lost which may be found in such competition as is possible. The canal affords a sort of objective standard by which rail rates may be judged, and acts, therefore, as a silent but eloquent warner to railroads not to drive things to extremes. A most interesting proof of this in Germany is afforded by the fact that railway managers, as a whole, oppose, whenever they can, the improvement of rivers or the construction or improvement of canals.

These considerations prove almost beyond a reasonable doubt that it lies in the interest of the country as a whole to secure in some way as extensive water connections as possible along the great lines

of national traffic. The Mississippi River and its tributaries, the great lakes and the ocean should be united so as to constitute one grand system of waterways. Where these connections can be best made is an engineering question on which I should not presume to express an opinion, if extensive surveys had not made tolerably plain the line along which one connection should be made. At least one of these waterways should run from the Northern Mississippi through the great lakes and Erie Canal to the ocean at New York.

A modern canal able to take in the largest boats that could navigate the Upper Mississippi, with all the improvements that belong to modern navigation, would open up boundless possibilities to the whole country. The advantage of such a waterway, while greatest, of course, to the sections most immediately affected, would by no means be limited to them, but would reach the farthest point of the country. It would correspond to all the conditions which modern society considers necessary to a reasonable canal system. It would consist of a series of canals connecting great natural waterways, with termini of an immense commerce, through which, therefore, a great traffic would be sure to pass.

Such water connections should, then, be secured in some way. If private enterprise and capital will do it under conditions which will conserve the interest of the public, let private enterprise and capital do it. If not, let the States do it; if they will not, then let the nation do it, for it is, after all, a national question and national interests are at stake.

The question may be raised as to how the funds shall be provided. Reasonable tolls would provide

an ample revenue, if the canals were really constructed on a proper scale. Ship canals joining the Mississippi and Lake Michigan and Lake Ontario and the ocean would develop a traffic far exceeding that of the Suez Canal, even in proportion to its length, and a very moderate system of tolls would pay interest and expenses. For this statement there is ample proof in the reports of engineers on the subject.

But even if this were not so, even if the government should have to construct and operate them at a loss, or even free of charge to the traffic moving upon it, the return to the country at large would be such as to repay the cost to the country many times over.

It is safe to say that no system of highways—land or water—adequate to the demands of modern civilization could ever be constructed and kept open if each individual portion of it were to depend for its existence on the tolls taken upon it for traffic passing over it. Imagine for a moment the result if we were to attempt to take tolls upon each mile, or even each ten miles, of wagon road in this country, sufficient to pay for laying it out and keeping it in order. The result would be the closing of much over 50 per cent. of the length of highways in the country, a consequent checking of the rate of progress and possibly a permanent tendency to a retrogressive movement. Freedom of locomotion is an absolute necessity of civilization, and the more it can be secured—not merely as a possibility but as an actual fact—the more rapidly, *ceteris paribus*, will civilization advance. The advantage of a system of highways, whether on land or water, is not to be judged, even

from a narrow commercial point of view, by the possibility of collecting tolls enough on it to pay for constructing or maintaining it, but by its general effect on the commercial and industrial progress of the country; and, judged from this point of view, there can be but little doubt that it would pay the nation well to open such a waterway from the Mississippi to the seaboard, at least along the line indicated, and perhaps in other places also.

There are probably other lines than these, at more places than one in the country, which should be taken in hand by the Federal Government, and certainly there are many which the States themselves should undertake on their own account. There should in some instances be a decided effort to regain control of certain canals before the railroads succeed in ruining them altogether. In others the State should keep control of the canals it owns, and far from proposing to sell or give them away, it should reconstruct them so as to make them able to meet modern demands. New canals may doubtless be profitably constructed in many places where they do not exist; but the first point is to hold on to existing canals until it is perfectly clear that they have no valuable function to perform in our transportation system.

Another type of canal which is now much coming into favor is that which brings home to a city, hitherto without them, the facilities of a seaboard city. The Manchester Ship Canal is an excellent example of such a type. Bremen, Brussels, Paris, Birmingham and other cities propose to construct such waterways. There are large possibilities in this country for such canals, and the future will doubtless see many such constructed.

Whatever one may think of the particular proposition of the foregoing paper, it is difficult to believe, in view of all the facts relating to the question, that the American people will not soon awake to the importance of the artificial waterway, and when they do they will give as careful attention to its development as they did sixty years ago, or as they have been giving to the railroad for sixty years past.

NOTE A.

A NEW SYSTEM OF PASSENGER FARES.

THE LETTER POSTAGE PRINCIPLE APPLIED TO RAILROAD PASSENGER TRAFFIC.

[*Abstract of a paper read by Professor Edmund J. James, of the University of Pennsylvania, before the American Academy of Political and Social Science, Philadelphia.*]

For the last nine months a most interesting experiment in railroad management has been going on in Hungary. The railroad managers in Hungary, and more particularly the Minister of Commerce, became convinced some time ago that a great reduction in passenger fares would have to be made. The passenger traffic in Hungary had remained under the prevailing system of management almost stationary for some time, and was far behind that of Germany and the other leading countries of Europe. It appeared necessary, therefore, to do something to develop travel, if possible.

As a result, a new system of passenger tariffs was worked out and put into operation on the first of August, 1889. The method adopted was that commonly known as the zone-tariff system, in which the rates are fixed, not according to the number of miles traveled by the passenger, but according to the num-

ber of zones traversed or entered upon during the journey. Starting from a given centre, the railroads are divided into fourteen zones or stretches. The first zone includes all stations within 25 kilometers of the centre; the second, all more than 25 and less than 40; the third, all between 40 and 55 kilometers, etc., each zone after the first up to the twelfth, being 15 kilometers long, or as we should perhaps better say wide. The twelfth and thirteenth zones are 25 kilometers wide, and the fourteenth includes all stations more than 225 kilometers away from the capital. Tickets are sold by zones, being good for all stations within the zone.

Two grades of local tickets were adopted, the first being to the first station and the second to the second. The third station comes within the zone ticket.

A normal fare was adopted per zone (taking 40 cents as the gulden) of 20, 16 and 10 cents per zone according to the class one uses—first, second or third. The fare for any zone up to the twelfth is found by simply multiplying the number of the zone into this normal rate. The fare for stations in the thirteenth zone is fourteen times the normal rate, except for the second class, in which case it is a trifle less. The fare for stations in the fourteenth zone, which includes all stations more than 225 kilometers, is sixteen times the normal rate, with the exception of second-class fare again, which is a trifle less. This system, as will be shown in a moment, introduced a great reduction in the average fare, and an enormous reduction in the long distance fare.

How radical a change this system implies, for a large part of the traffic can be seen in the extreme cases, *i. e.*, in those in which the reduction has been

greatest. The fare for all stations in the fourteenth zone, which, as above said, includes all stations more than 225 kilometers from the capital, are 8, 5.80 and 4 gulden respectively for the three classes, corresponding to $3.20, $2.32 and $1.60. The greatest distance which can be traveled for this sum is 731 kilometers, or 457 miles, making the rate per mile from Buda Pesth, for example, to Kronstadt 70, 51 and 36-100ths of a cent for the three classes respectively. If we had the same rate in this country it would be possible to buy a railroad ticket to Chicago from New York for $3.10. The fare from New York to Philadelphia would be 32 cents.

The above is, of course, the extreme rate at one end, but the extreme rate at the other end of the same zone is still a great reduction on old rates in Hungary, as will be shown in a moment. It represents also a much lower rate than we have anywhere in this country. The station at the limit of the zone nearest to the starting point would, of course, be 225 kilometers, about 140 miles. The rates to this being the same as to the farthest one away are only 2.2, 1.7 and 1.1 cent a mile for the three classes. If we count the extreme distance within the other zones running backward from the fourteenth, we shall find the rates to be about 1.7, 1.1 and .6 of a cent a mile, which are far below anything which we can show in the way of low rates for such distances.

The reduction, as compared with the old rates, is enormous. The old rates from Buda Pesth to Kronstadt were 44, 31 and 22 gulden; the new are 8, 5.8 and 4, a reduction of 82 per cent. This represents the extreme reduction, the per cent. of reduction growing smaller as you go nearer to the starting point. At Klausenburg the old rates

were 24, 17 and 12, as compared with the rates just given, the distance being 400 kilometers, a reduction of 66⅔ per cent. At Medzo Telegd, a distance of 271, the reduction is still more than 50 per cent., and at 100 kilometers the reduction is still nearly 50 per cent., while local reductions have also been very considerable.

The simplification of the tariff is very great. Under the old system the number of distinct tickets which had to be kept in every large office was nearly 700. It is now only 92.

The railroad tickets are now placed on sale like postage stamps at the postoffices, hotels, cigar shops and other convenient places. The public is greatly pleased at the discarding of the complicated machinery of ticket selling as practiced under the old system.

The most interesting thing, however, in this experiment, is the way in which the passenger traffic has increased under the stimulus of the new rates. The time is too short to enable us to draw definite conclusions, but the facts are striking and significant. The number of passengers during the last five months of 1887 was 2,389,400; during the same period of 1888 was 2,381,200, while for the same period of 1889—the first period under the new system—it was 5,584,600, an increase of over 133 per cent.[1] The receipts from the traffic under the new

[1] According to the latest report brought down to March 31, 1890, the traffic on the state railways had increased to 7,770,876 as compared with 2,891,332 in the corresponding period before the introduction of the zone tariff, an increase of 169 per cent. The result is still more remarkable with regard to traffic between neighboring stations. Whereas under the old system only 255,000 persons used the railways for such journeys, their number rose during the above eight months to 4,367,586. It is reported that the government contemplates a still further reduction.

system were over 18 per cent. greater than under the old, while the operating expenses under the new system were not greater than under the old. In other words, passenger traffic will respond to lower rates, a thing which some railroad managers have denied.

Hungary was in some respects the most unfavorable country in Western Europe for such an experiment. It has relatively a small population, scattered over a large territory, poor, ignorant, conservative, the kind of a population not likely to respond quickly to such a thing as a reduction in long-distance railroad fares. The success of the experiment has fixed the attention of railway managers on the Continent. Austria is about to adopt a somewhat similar system. French, Belgian and German engineers are going to Hungary to study the system on the spot.

It would be well for our own railroad managers, who complain that passenger traffic is not profitable, to look into the matter. The American people, reputed to be the most restless in the world, does not have nearly as many passengers per head of the population as England, and it is far exceeded in the number of passengers to mile of railway by half a dozen countries of Europe. This is the result of our peculiar economic conditions in great part. It is also to some extent due to the fact that our railroads have never given anything like the same attention to developing passenger traffic as they have to freight traffic. The example of Hungary is of special value to us because its economic conditions are in many respects similar to our own, and because the railways involved in the experiment are to a large extent private and not State railways.

CANALS

AND THEIR

ECONOMIC RELATION TO TRANSPORTATION.

BY

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Canals and Their Economic Relation to Transportation.

BY LEWIS M. HAUPT, A. M., C. E.,

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The science of Engineering is pre-eminently one of economics. Most of the problems arising in practice involve the adaptation of the means to the end, in the most judicious manner. The question which invariably presents itself to the engineer is, how to obtain the best result at the least cost of construction and maintenance. This is a complicated problem not to be solved solely by the aid of formulæ or mathematics, although they are important auxiliaries, but largely by experience, precedents and good judgment. It includes also a careful weighing of the relations of cause and effect, action and reaction, revenue and expense, which are functions of many variables; but the physical elements of the problem may be readily reduced to finding the *locus of the line of least resistance*, which will, in general, be that of least cost and greatest revenue. Such is in substance the task submitted to the projector of a new line of communication.

He is to seek out the location which will cost the least, be most direct, produce the minimum of mechanical resistances, develop the maximum amount of traffic at paying rates and cost the least to main-

tain and operate. Here too the question of time, or velocity of transit, enters as an important factor, not to be overlooked.

The more closely the solution may be made to comply with these conditions the better will be the result; hence it becomes necessary to consider the character of the physical resistances to be surmounted in selecting such a line, in connection with the kind of traffic, motive power, speed and cost of movement.

The principal resistance to be overcome is that produced by the force of gravity acting upon a body moving over an inclined plane. If the direction of the movement be downward, the effect of the force is to produce an acceleration—thus diminishing the amount of any auxiliary power which may be required to propel the load; if upward, a retardation ensues and a consequent increase of power will be required. It has therefore become a maxim in transportation that the grades should be with the heavier traffic.

Since flowing water naturally seeks the line of least resistance and will not run up hill, it is but rational to find the rivers utilized, so far as their variable stages will permit, for purposes of traffic as well as for water supply and power;—but the channel being sinuous, and not often lying in the direction of the desired movement, artificial canals were soon cut for the purpose of still further adapting this natural roadway to the wants of mankind.

Moreover, the frictional resistances of a solid passing over or through a fluid and the great superiority of the latter as to continuity and smoothness, over a roadbed of any solid material, are advantages which no mechanical constructions can hope to rival, and give to the waterway an inherent element of cheap-

ness which cannot be excelled. If therefore the terminals of a line can be connected by water at a cost even greater than that required for rail, it would seem to be the logical and proper channel of transportation. Here, however, arises one of the difficulties, for the applicability of the water route is restricted to relatively narrow limits by the topography as well as the metrology of the country, whilst the railway possesses almost unlimited range in both vertical and horizontal directions, and there are no obstacles which it may not either surmount or pierce.

Where water is abundant, however, the vertical range of a canal may be greatly extended by the use of locks, thus rendering it practicable even in hilly sections, and there are very extensive areas in the United States where it would only be necessary to open what might be regarded as an irrigating ditch, without locks, to provide the necessary communications as feeders to trunk lines for a large proportion of the population in the great basin of the Mississippi and its tributaries.

The great flexibility of the railway system, enabling it to ramify into all parts of the terrane, has resulted in the enormous development of 158,000 miles in about half a century, in the United States alone, and has caused the superior advantages of the water way to be either overlooked or ignored. A reason for this may be found doubtless in the fact that the general government claims jurisdiction over the improvement of all navigable waters not lying wholly within states, and hence it is difficult if not impossible, for corporate powers to execute any works which would look to their amelioration or utilization without first

securing the consent of Congress, which, in many cases, involves a serious loss of time, with great uncertainty as to the result.

So long as the policy of "here a little and there a little" exists, nothing can be expected for a rational and systematic development of these natural channels of commerce, and the attention of economists interested in the cheapening of transportation, and in the enriching of the country by encouraging mining, manufactures, agriculture, and all those industries which are dependent upon the movement of materials or products, must be restricted to the development of such artificial water ways as may be practicable, and give fair promise of returns.

Here again the field is greatly restricted by a policy of railroad companies, which has resulted in many cases in the roads purchasing the control of existing canals in competition with their lines, under the impression that such canals were injuring their business. It was found to be an indisputable fact that the cost of movement by canal was less than that by rail, and hence the determination to exterminate or control the former. The result is that the producer must pay the increased rail tariff to the railroad company, while the volume of the movement is largely decreased, for many articles which before had a market value at the lower rate are now rendered worthless.

Nevertheless the competition with the few surviving canals and with other railroads has compelled the managers of these lines to seek every possible method of reducing expenses and of lessening the tariffs so as to approximate to those by water carriage, but even yet they are still in excess of the rates by these artificial channels.

The most recent movement in the direction of economy over land is the large increase of carrying capacity of the rolling stock whereby the ratio of live to dead load is about doubled, being now nearly or occasionally fully two to one. If there be no back loading it is equivalent to one to one for the round trip, other things being equal. But this increase of rolling load involves additional expenditures for road-bed and maintenance, thus adding to the capitalization. Still the great reductions effected, at the present time, by the most thorough system and rigid economy, are not yet able to bring the cost of movement by rail within reach of that by canal. If the comparison be made with deep draught vessels on rivers, lakes, or the ocean, the results are far more unfavorable for the railroads.

Thus if the cost of transportation on the Erie canal be taken as a basis, there will result the following values :

Cost by canal per ton per mile.....less than 3.0 mills.
Cost by lake, 14 to 16 feet draught.....1.2 "
Cost by ocean, 25 feet draught.....0.5 "

If the canal boat depth be taken at five feet, that of the lake propellor at fifteen, and that of the ocean "tramp" at twenty-five, their ratios will be as one to three, to five. The reciprocals of these numbers are one, one-third and one-fifth, or 1, 0.33 and 0.20; while the relative rates reduced to the unit as a standard would be one, something more than 0.40 and a little over 0.17, varying with the canal rate per ton per mile.

By comparing these figures it will be seen that at these rates, they are so nearly coincident as practically to be stated in the form of a law, viz : *The cost*

of movement on water is inversely proportional to the draught of the vessel. It is true that we are here comparing artificial and natural waterways, but as this canal is the enlarged Erie, and free of tolls, the cost will not differ very greatly from an improved river navigation of equal draught.

These results demonstrate the great economy of increased draught, and furnish a clue to the reason for the abandonment or failure of many of the early canals as constructed in the first three decades of this century with their insufficient depths and limited capacity.

To obtain increased draught, it may be urged that the prism of excavation for a given length of canal must increase as the square of the depth, whilst the cost of movement only varies inversely as the first power. But the capital invested in construction is only one factor in the cost of operation, and the length of the boat may be increased without adding materially to the resistance which it generates in passing through the water. If the beam be also widened proportionately the capacity of the boat may be made to increase as the cube of the depth, while the cost of construction will vary as a fraction of its second power.

With this view of the subject it will certainly merit the attentive consideration of traffic managers, as well as consumers and producers who are so vitally affected by the tariffs on freight.

Again, if it be true, and there would seem to be little room for doubt, that on a well appointed and well managed canal the *cost* of traffic is less than on a standard railroad, why should not the managers of such roads, who may at the same time control a

parallel line of canals, transport a large portion of the lower grade freights via the water way with the same profit to the shareholders and a greater benefit to themselves and the producers due to the lesser tariff? Such a policy has invariably resulted in augmenting the business and increasing the profits; and it is difficult to understand why it should not be more generally realized and adopted.

In an argument before the Committee on Commerce, several years since, Mr. Albert Fink, then the railroad Commissioner of the Trunk Lines, stated:

"The competitive railroad tariffs for the interstate commerce are not, as is so generally supposed, under the absolute control of railroad managers, but the carriers by the water routes really establish these tariffs, and the railroad managers have nothing to do but to conform to them. The water routes not only control the tariffs of these immediate railroad competitors, at points where they can render like service to the same people, but their influence reaches directly and indirectly to the remotest parts of the country. * * * It will thus appear that the railroad companies fully recognize the potent influence of water competition and are not at all afraid of it, but on the contrary, they have met it and must meet it wherever they find it, without complaint and as one of the inevitable conditions under which they have to struggle for existence."

It would seem however, that the railroads have in consequence of this effect, conceived a natural animosity to the canals, and the result has been a war of extermination, and that the object of the railroad managers in acquiring possession of the canals is not to improve or utilize to the greatest extent the capacity of the latter, but to eliminate it from the field as a competitor.

At this time, too, when it is credibly reported that an organization has been formed of the railroads west of Chicago for the purpose of defeating the proposed enlargement of the Illinois and Michigan Canal, so as

to render it navigable for vessels of greater draught, it is particularly appropriate to recall the words of Ex-Senator Windom, (now Secretary of the Treasury) then chairman of the Committee on Transportation to the Seaboard. In addressing the Senate, on June 10th, 1878, during the consideration of the bill "making appropriations for the construction, repair and preservation and completion of certain public works on rivers and harbors," he said:

"The chief instrumentalities by means of which these (competitive) forces will exert their power are the Mississippi river on the one side and the Northern water routes on the other. * * * Both routes constitute indispensable parts of one grand system. * * * Each is needed to regulate the other, and both as regulators of railway charges. Each has some advantages which the other lacks and some impediment which the other has not; but on the whole their trade forces, commercial facilities and economic capacity for cheap transportation will be so evenly balanced as to insure a healthy, active and permanent competition. It will be as impossible for them (the railroads) to combine to put up prices as to effect a combination of interests between Chicago and St. Louis or New York and New Orleans. The interests of the lines themselves are necessarily antagonistic, and as each will be an open, free highway to everybody who chooses to float a vessel upon its waters, combination will be simply impossible and competition the inevitable law of their existence. But the competitive power and influence of the two great contestants (the water and the railroad lines) will not be limited to any one locality, but will extend to nearly every State in the Union, and will hold in check and regulate the charges on every railroad from the interior to the seaboard. The wide sweep of competitive influence exerted by the Erie canal is not generally understood or appreciated. You would doubtless be surprised, Mr. President, if I told you that the 'little ditch' which runs through your State holds in check and regulates nearly every leading railroad east of the Mississippi river, and that it exerts a marked influence on the cost of transportation over all the country extending from the interior of the Gulf States to the St. Lawrence river, and from the great plains of the eastern foothills of the Rocky Mountains to the Atlantic Ocean. And yet such is the fact."

This generalization is then followed by extensive quotations from Mr. Albert Fink, in support of these statements, to the effect that—

"The Erie Canal and the lakes exercise their influence over the Southern country until it reaches a line where low ocean rates from New York to the Gulf States—Mobile, New Orleans and Galveston—exercises their influence upon the rates to the adjacent interior points—to Augusta, Macon, Selma, Montgomery, Houston, &c.—so that it may be said that the all-rail rates are kept in check by water transportation. There need be no fear that extortionate rates will be charged by railroad companies; on the contrary, the fear is that water competition will be so effective as to prevent railroads from securing paying rates."

The closing sentence reveals the reason for the policy of the railroads and shows how vital it may be for a railroad in competition with a canal to gain control of the latter; but not, we think, for the purpose of exterminating or abandoning it. Rather let us say as an important and useful auxiliary whereby the revenues of the railroad may be augmented without taxing the public to maintain the higher railroad rate.

It is a well remembered fact that after the enlargement of the Schuylkill canal in 1846, the charge per ton on coal from Pottsville to Philadelphia, about one hundred and six miles, was forty cents for toll and fifty for freight, making a total of ninety cents; whereas now, since the canal has been acquired by the Philadelphia and Reading Railroad Company, the charges are the same as those by rail, or one hundred and seventy cents for the same service. Thus nearly one hundred per cent. is paid by the consumers, unnecessarily, and the price of all articles manufactured from this coal is increased accordingly.

At the old rate of nine mills per ton per mile there was a large margin for profit on the canal, and at

this same rate, with the exceptional facilities possessed by this down-grade railroad, there should still be a handsome profit. Yet the competition being destroyed, the policy of charging "what the traffic will bear" is too great to be resisted, and industries are stifled.

In an able article on American Industrial Progress, the London Engineering of July 5, 1889, says, after quoting the statistics of our material growth, as evinced in the increase of agricultural products:

"Under every heading there has been an enormous expansion of business, accompanied in the majority of cases by a considerable fall in values." * * * "In other words 2,660,000,000 bushels in 1887 were worth less than 1,330,000,000 bushels twenty years before."

"This very striking decline of prices has been due no doubt to better systems of cultivation, and to economy in many directions, but it has been chiefly caused by the reductions that have taken place in the cost of transport and the facilities that have been provided throughout the United States for the distribution and consequent equalization of prices of the products of agriculture generally. * * While in 1860 there were only 30,626 miles of railroad, and in 1870, 52,865, in 1888 the mileage had expanded to 157,000; but the increase in traffic has been phenomenal, and is closely allied to the remarkable reduction in the rates of freight that has taken place within recent years. We find for example, that in 1868 the average freight charge on the eighteen principal railroad lines of the United States was 2.453 cents per ton per mile. But in 1878 it was only 1.401, being a reduction of 42 per cent. In 1878 there were many who believed that there was no further room for reduction of freight rates, yet we find that in 1887 the average ton-mile rate on the same roads was only .974 cents, or a further reduction of 30 per cent. In 1887 the great bulk of the freight carried on the railroads of the United States was taken at 60 per cent. less than in 1868. This remarkable movement has been the life's blood of the industrial and commercial development that has occurred in the interval. The freight earnings have kept up and they amounted to over $636,500,000 in 1887 as compared with 294,500,000 in 1871, and the net earnings within the same period have advanced from $141,750,000 to 335,000,000. Obviously if the rates of twenty, or even ten years ago had been kept up to the present time, the relative net earnings would probably have been higher, but the business done would have been infinitely less. The total tonnage transported in 1887 amounted to 552,000,000 tons of freight of all kinds."

A similar development has taken place in the mineral industries of the United States, due to the increased facilities for distribution. The basis of mineral wealth is coal, and it is scattered through twenty-eight states and territories. In 1870, less than 33,000,000 tons were mined in the nineteen states in which it was then known to exist, while in 1887 the output had increased to 111,000,000 tons. But this is only one of the forces taken from the storehouse of a beneficent Creator. Another remarkable development is to be noted in the case of natural gas, which was almost unknown but a decade ago, while in 1887 it represented over $16,000,000. The existence and production of petroleum have also largely increased. Within a few years the consumption of copper has doubled, whilst iron and steel have kept pace with coal and other fuels.

These magnificent results are, to a great extent directly due to the reduction in the tariffs charged by the transportation companies, which, as has been shown, are regulated by the rates fixed by the water ways ; and yet they are not as low as they may be, for it is manifest there is still a large profitable margin on the rates for freight in bulk by canals of enlarged capacity, which might be utilized for the public benefit and the further extension of the market range of our manufactured articles, in the trade of the world.

The importance of ship canals and their utility in shortening the commercial routes of the world is universally conceded, yet there are other canals, purely local in their functions, which carry a larger business than even that at Suez. For example, the Sault Ste Mary Canal, which was recently enlarged to accom-

modate the rapidly increasing commerce of the Lake Superior region, and which in consequence of its latitude is closed nearly fifty per cent. of the time, has outstripped its oriental competitor in the volume of its tonnage—and it is again too small to handle the rapidly increasing traffic.

In 1870, when the Suez canal was opened, the number of vessels in transit was 486, the net tonnage 436,609, and the average toll per ton $1.99. In 1888, the corresponding figures were 3,440 vessels, 6,640,834 tons, and $1.89 per ton toll. The gross receipts from tolls were $12,607,524.00. The canal is open all the year.

From 1881, when the Sault canal was enlarged, to 1888 inclusive, it was open an average of 193 days of each year, or fifty-three per cent. of the time. The number of vessels increased in the nine years from 1881 to 1889, from 3,304 to 8,832, the net tonnage from 1,802,571 to 6,932,203,and the operating expenses per ton have fallen from 12 mills in 1882, to 5 mills in 1888. In 1889 the net tonnage was 7,516,022, and the number of vessels 9,579.

Per contra we find at the other end of this chain of great lakes, the Erie canal, on which the amount of traffic has remained remarkably constant for fifteen years, fluctuating at about five million tons.

The increase of tonnage is carried by the railways, and it has expanded to the enormous amount of 35,000,000 tons, which, it is safe to assert, would still be in the distant future had it not been for the existence and silent, yet potent, influence of this artificial water way, which has inspired competition and controlled rates. Yet this is the friend which the railways desire to strangle upon the plea that its days

of usefulness are over. Such a result would be a calamity to the country. On the contrary, the beneficial influence of this western water way should be extended as rapidly as possible in both directions,—by the National Government completing the "Great Belt" route from the Mississippi to the Atlantic, and along the coast by the inner line, so frequently described, to Florida, as a measure of national, commercial development and defence. It should be the first step in the defensive measures adopted by Congress, for it is of little use to build vessels to run a blockade and take the risks of storms, on the open ocean, when far greater mobility and safety may be secured inside of the coast line.

But there is another strong reason why the enlargement of the link between New York and Philadelphia, via the Delaware and Raritan Canal, upon a revised location, should not be longer delayed. It would still further increase the facilities existing between the two largest and most populous cities of the country, and would affect directly the local interests of at least five millions of people, and indirectly the welfare of sixty millions.

Possibly it is because of the maxim, "what is everybody's business is nobody's business," that this work has not long since been undertaken, and yet it would seem to be in accordance with the history of many similar works in this country which are limited to the confines of a single state, that they are left to the enterprise and resources of said state to be executed.

What shall be thought of the commercial activity and energy of Americans, when so important an undertaking languishes for a century, while Englishmen do not hesitate to undertake a work of greater

magnitude with smaller prospects of returns in the construction of the Manchester Ship Canal, thirty-five miles long, at a cost of a million dollars per mile, and between cities having populations of only 575,000 and 350,000 respectively?

All the railroads intercepted by the English canal, and which opposed its franchises, are now compelled to modify their location and grades so as to surmount an elevation of seventy-five feet in the clear above the water surface of this canal. The total amount of excavation for this work amounts to over 44,000,000 cubic yards, which must be removed prior to January 1, 1892. The contract was let in January, 1888, and already considerably more than half of the excavation is completed. Exclusive of right of way and terminals, this work has been let in one contract for $22,500,000. Yet there has been no lack of railroad and even canal facilities. Then where shall we look for justification for this enormous expense? It is to be found merely in the desire to avoid the transshipment or break of bulk at Liverpool, and to provide for a continuation of the voyage 35 miles further by water, at canal rates, into the interior. This channel is to be 26 feet deep and 120 feet wide.

There are some remarkable phases connected with the history of this Delaware and Raritan link of the internal water way, which are full of instruction and suggestion. It is only necessary to review the annual balances, to note the great fluctuations in net returns which have taken place, and when these results are connected with the dates of changes of administration, the effect of the policy of the managers becomes at once remarkably prominent.

The chronology of the important changes is given herewith that the relation of cause and effect may be more readily discerned.

The Delaware and Raritan Canal Company and the Camden and Amboy Railroad Company were both chartered in February, 1830; the former to construct a canal to connect the Delaware river at Bordentown with the Raritan at New Brunswick, a distance of 44 miles; the latter, to connect Camden with Amboy by a railroad across the state of New Jersey. These two companies were consolidated by an act passed in February, 1831, and were thereafter conducted by a single management. The main lines of the railroad and of the canal were both completed in the year 1834, and the branches in 1838. In the meantime the Philadelphia and Trenton Railroad Company was chartered, and in 1836 in was merged into the United Companies by the purchase, by them, of a controlling interest in its stock. At the other end of the route to New York, the New Jersey Railroad and Transportation Company was operating an independent link between New Brunswick and Jersey City, in opposition to the steamers from Amboy to New York, and to extinguish this rivalry an agreement was made in January, 1867, between this company and the others already united, whereby it entered the combination on condition of an equal division of profits between these four companies, viz.: the Delaware and Raritan Canal Company, the Camden and Amboy Railroad, the New Jersey Railroad and the Philadelphia and Trenton Railroad Companies—thus forming the United Companies of New Jersey.

In his annual message to the stockholders in 1870, the President of the Pennsylvania Railroad Company

called attention to the desirability of securing a through line to New York, by the lease of the lines of these United Companies, and in June of 1871 this lease was consummated, and the entire property was secured for a period of 999 years for an annual rental of ten per centum guaranteed on the aggregate capital and dividends to an equal extent on the Philadelphia and Trenton Railroad.

There is a bit of unwritten history connected with this transaction which is well authenticated, and which serves to explain to some extent the subsequent events relating to this important line of traffic. When it was learned that this lease was contemplated, the President of the Philadelphia and Reading Railroad also entered the field as a competitor for the use of the canal through which that company was then shipping nearly two million tons of coal per annum.

To avoid complications from competitive bids, an alleged agent made an agreement with the Philadelphia and Reading Railroad whereby the use of the canal was assured to that company on satisfactory terms, provided they would withhold their bid. This they did, and, as the story goes, after the lease was effected, it was found that the agent so-called, was acting without authority, and the trade of the Philadelphia and Reading Railroad Company was soon after driven from the canal. Thus was killed the goose that laid the golden egg. This outlet by the canal to New York being thus cut off, the P. & R. R. R. Co. a few years later, or in May, 1879, succeeded in effecting a lease with the North Pennsylvania and the Delaware and Bound Brook Railroads, and thus opened up a new competitive route to New York by rail. The colliers were put on in 1869 to carry coal

via the river and ocean to eastern and southern ports. The Central Railroad of New Jersey was also leased May 29, 1883, for 999 years, but this lease was surrendered January 1, 1887.

As the sequel will show, the loss of this heavy coal tonnage was a serious matter for the canal and the United Companies, but when great transportation corporations cross swords, the stockholders as well as the public must bear the brunt of the conflict.

An examination of the balances of the Delaware and Raritan Canal Company, hereto appended, show a remarkable curve of fluctuations. There is a rapid increase of profits up to the year 1866, when the net revenue reached a maximum of $933,642.86 over and above the gross expenses, which were only $360,513.83. In other words the profits were nearly three hundred per cent. of the operating expenses—truly a magnificent showing.

The traffic through the canal, so far as it can be determined from the incomplete tables accessible, was larger this year than any other. From this time the net returns are found to decrease to date—reaching a minimum in 1887, when they were reported as only $80,059.91. But this does not represent the true condition of affairs, for from the time of leasing the United Companies of New Jersey, the Pennsylvania Railroad Company guaranteed ten per cent. on the capital stock of the several companies, and at that time the canal capital was valued at $5,847,400, making a fixed charge of $584,740.00 to be paid annually. It will be seen that after the date of the lease there were but two years when the balance exceeded this amount. Hence, it is said "the canal does not pay" and its traffic is allowed to fall into decay. The

same is true, but to a much greater extent, as to the deficit on the railroads, and the annual reports of the Pennsylvania Railroad will show a loss on these United lines reaching, in some years, the large amount of over one million dollars. But this is the price the company elected to pay for the privilege of shipping its traffic at the Jersey City and other termini, instead of at Philadelphia ; and there are possibly compensating advantages which do not appear on the balance sheets of this part of the route.

It is difficult to understand why the more bulky, inferior freights are not transported via the river and canal as formerly, instead of by the more expensive rail routes, even if the charges by canal be kept, by the management, the same as those by rail ; for the cost of the movement being less, the profits would be increased and a large part of the rolling stock of the railroads would thus be released for use on the western branches where there is great dearth of cars. It would, it is believed, be still better if the capacity of the canal were enlarged and its alignment rectified, thereby shortening the distance, about six miles, and thus promoting an additional traffic between Philadelphia, New York and other cities by these additional facilities.

Either this, or else let the canal be sold to the United States and be improved by it as a part of the internal water way to be made free as the rivers. Thus the railroad would eliminate an annual deficit of over half a million dollars and the country be greatly benefitted. It will be presumed that this free water line would be detrimental to the railroad interests, but paradoxical as it may seem, the results are generally the other way, and the existence of a

free navigable channel is found to be beneficial to the railroads bordering its banks. The reason is manifest. Population is more dense where there are facilities and an independent outlet, and population is the life of trade.

The canal balances, so far as they could conveniently be ascertained, are shown in the annexed tables:

	Expenses.	Receipts.	Profits.	Inc. or Dec. over previous years.
1852	$132,048.43	$376,585.11	$244,536.68	[1]89.450.63
1859	157,068.66	492,198.00	335,129.34	
1860[2]	117,968.86	546,650.59	428,681.73	
1861[1]	157,509.53[1]	469,895.73	312,386.20	
1862[4]	172,091.80	517,655.63	345,563.83	
1863[5]	190,883.89	728,365.73	537,481.84	
1864[6]	280,390.29	1,065,024.26	784,633.97	
1865[7]	317,577.75	1,128,007.30	810,429.65	
1866	360,513.83	1,294,156.69	933,642.86	
1 yr. missing	.....	.....	.....	
1868	325,560.56	912,107.77	596,547.21	
1869	311,681.86	1,043,865.64	731,683.78	
1870	602,173.73	1,222,995.06	620,821.33	
1871	701,029.96	1,429,594.11	728,564.15	
1872	1,016,037.49	1,524,605.24	508,567.75	
1873	883,321.46	1,590,100.12	706,778.66	
1874	768,416.64	1,320,519.23	552.102.59	
1875	541,035.76	1,067,660.58	526,624.82	
1876	523,306.02	882.551.78	359,245.76	
1877	477,606.78	896,569.65	418,962.87	
1878	389,720.25	702,083.45	312,363.20	
1879	326,924.85	695,959.10	369,034.25	
1880	331,343.53	419,430.57	88,087.04	
1881	232,314.17	541,076.73	308,762.56	
1882	294,780.13	553,417.70	258,637.57	
1883	291,574.56	548,055.21	256,480.65	
1884	381,403.87	547,710.66	161,306.79	
1885	342,373.94	529,079.06	186,705.12	
1886	390,705.41	535,525.99	142,820.58	
1887	414,158.81	494,218.72	80,059.91	
1888	430,680.31	525,748.92	95,068.61	
1889	.....	.....	.....	

1883—To pay on account of dividends on canal, $584,740.00
" " transient dues and taxes, 74.530.24

Main line, 44; feeder, 22; total, 66 miles.

[1]During the civil war, 1861–1865.

[1]In the report for 1861, the Directors say:—"The State Directors having observed a movement in the Congress of the United States in reference to the construction of a Military and Postal Railroad between the city of New York and Washington, deem it their duty to call the attention of the Governor to the subject, that he might adopt such measures as in his judgment would best protect the interests of the state; and they now express the sentiment that it would not be expected that the state of New Jersey would quietly submit to such an encroachment upon her sovereignty and the destruction of an important pecuniary interest, unless the safety and best interests of the country required it. They are fully persuaded that no such necessity does exist."

[2]For 245,825 tons of "superior" freight the charge was eight cents per ton. For 1,394,172 tons of "inferior" freight the charge was two cents per ton.

[3]"For maintaining and operating the canal, including repairs and transit duty paid to the state."

[4]The report for 1862 renews the protest against the Military and Postal road between Washington and New York by Congress.

[5 6 7]A still more emphatic protest.

Incomplete Tabular Statement of traffic through the Delaware and Raritan Canal.

	1852.	1859.	1860.	1861.
Coal, tons.....	998,302	1,155,261	1,283,264	1,022,902
Timber, c. ft....	2.734,031	1,606,558	2,314,749	1,472,475
Lumber, b. m...	6,655,916	11,886,488	11,878,913	6,502,020
Grain, bushels..	840,559	657,736	742,001	825,578
Flour, barrels...	119,166	164,219	211,203	101,202
Iron, tons.....	31,391	31,825	40,032	28,766
Mdse., tons.....	135,299	209,481	227,394	239,642
	1862.	1863.	1864.	1865.
Coal, tons.....	1,007,718	1,262,032	1,329,082	1,552,108
Timber, c. ft....	2,282,789	3,174,035	3,050,470	2,878,206
Lumber, b. m...	14,232,470	13,839,792	14,358,992	14,143,297
Grain, bushels..	902,426	2,644,745	2,072,821	2,476,683
Flour, barrels...	195,022	248,352	266,647	208.838
Iron, tons.....	39,614	48,661	48,648	41,143
Mdse., tons.....	322,727	357,169	287,358	295,388
	1866.	1867.	1868.	1869.
Coal, tons.....	2,282,203		1,923,532	1,888,003
Timber, c. ft....	2,864,915		2,468,568	3,328,731
Lumber, b. m...	16,362,237		18,893,913	15,811,117
Grain, bushels..	3,379,088		1,974,227	1,434,250
Flour, barrels....	185,694		21,369	281,646
Iron, tons.....	55,291		63,142	54,893
Mdse., tons.....	354,341		402,931	468,605

The gross tonnage for a few other years not itemized, is reported to be, for 1874, 2,308,670; for 1875, 1,958,004; for 1876, 1,897,708; while for 1868 it was 2,519,285; and for 1869, 2,547,212; or over half a million tons more than after the lease.

In 1874, the coal shipments were but 1,548,303 tons.

The main line was 44 miles in length, with a feeder extending from Trenton to Bull's Island, 22 miles, giving a total of 66 miles. It was 80 feet wide at the surface and seven (7) feet deep.

The Report of 1882 says:

"In consequence of the large increase of transportation upon the canal, the company have decided to enlarge its dimensions so as to leave in all places eight feet clear depth of water, and to lengthen the locks from one hundred and ten to two hundred and twenty feet, so as to take in two of the present boats, or one of two hundred and twenty feet in length and capacity of five hundred tons.

The estimated cost of these improvements, and to carry out the plan of enlargement, is $700,000."

In the Report for 1866 are to be found these items:

The cost of the Camden and Amboy Railroad and equipments is	$10,099,000.97
The cost of the Delaware and Raritan Canal and appurtenances is	$4,381,251.28
The receipts of the Camden and Amboy Railroad and Transportation Company for the twelve months ending December 31, 1866	$4,312,895.00
Expenses	3,801,732.45
Current net	$511,162.55
The receipts of the Delaware and Raritan Canal Company for twelve months ending December 31, 1866	$1,294,156.69
Expenses	360,513.83
Current net	$933,642.86

This statement shows very conclusively that upon a capital of over four million dollars invested in the

canal, the net returns were nearly 23 per cent.; while upon the capital of over ten millions invested in the railway, the net return was only a little more than 5 per cent. For an equivalent return, the railroad capital should have produced a profit of $2,152,100. In other words, although the rates by canal were less than those by rail, the cost of maintenance and operation were so much smaller, that its returns were nearly five-fold greater than those of the railroad. It was further stated that "while the business of the railroad, both in passengers and freight was not equal to that of the previous year, that of the canal was increased to almost its entire (present) capacity. A new outlet lock is being constructed at New Brunswick, which will greatly facilitate the dispatch of their tonnage."

Interesting as this history may be, it is not an isolated case. It is a common experience to note in our technical press such items as this. "The Old Pennsylvania Canal, that has been in service for sixty years, is now practically abandoned, and its bed is to be used by the Pennsylvania Railroad. This road owns the canal, and is at work destroying the old aqueducts, bridges, etc., and is straightening out its line in many places by using the canal bed. Portions of the canal were in use up to the present year."[1]

The history of another of the great arteries of Pennsylvania, the Schuylkill Navigation Company's Canal, is nearly the same. Efforts are now making to divert it from its original purpose of a navigable channel, to an open aqueduct for the supply of potable water to the city of Philadelphia, but there is a somewhat pathetic story connected with its early life

[1] *Engineering News*, Jan. 4, 1890.

which will serve to illustrate the great service this canal has rendered in making Philadelphia what she is to-day.

Although coal was quarried at Summit Hill in 1792, it had no market value, as there were no means of transporting it and it was not known how to make it burn readily.

The Schuylkill Canal was opened from Philadelphia to Mount Carbon in 1825, but shortly before that date a prominent citizen had a load of coal conveyed by wagon from the quarry at a cost of thirteen dollars and a half. He had subscribed largely to the stock of the proposed navigation company, and his friends thought him visionary. Upon the arrival of the coal he had a grate constructed in his parlor, upon which a "stone coal" fire was soon kindled. His house was besieged by the interested and curious citizens of Philadelphia, who wished to see this marvelous phenomenon. Amongst the visitors was an acquaintance who had protested vigorously against his friend's extravagant investment in the canal securities, but who, on seeing the coal fire burning so successfully, and throwing out such great heat, gave vent to his pent up feelings in tears. When asked why he displayed so much emotion, he replied, that for years he had been deeply concerned about the welfare of his children and grand-children, in wondering how they could obtain sufficient hard wood for fuel during the winters, when it was then selling at $18 a cord for hickory, and $13 for oak. His fears were allayed by the phenomenon before him, and his gratitude to a beneficent Creator thus expressed itself.[1]

[1]This anecdote was related to the writer recently by Hon. Fred'k Fraley, who was an eye witness of the events described.

Instead of wood at the above prices, or coal hauled by wagon at $13 for the partial load, the canal subsequently delivered unlimited quantities of this fuel at the rate of 90 cents per ton for tolls and freight. The value of this stimulus to the manufacturing industries of Philadelphia and the adjacent territory, can hardly be over-estimated, and had it not been for the impetus given to the commerce of New York by the opening of the Erie Canal in 1825, Philadelphia might have retained her envied position as the first city in population in the United States.

This early canal through New York State had a prism of only four feet draught, carrying boats of seventy-six tons capacity, and was operated at a cost of 4.14 mills per ton per mile, while on the enlarged canal having a depth of seven feet and boats of 210 tons capacity, the reduced cost was 2.16 mills.[1] Again, upon the projected re-enlarged 8 feet canal, with boats of 600 tons, the cost was estimated by the State Engineer in 1863 at only 1.04 mills per ton per mile. Before this canal was built the cost of transportation from Buffalo to New York was $100 per ton, and the length of time required for the trip was *twenty* days.

On the 14th of March, 1835, Messrs. J. B. Jervis, H. Hutchinson and F. W. Mills reported to the canal Commissioners that: "Taking the facts we have obtained as a basis, we find the relative cost of conveyance (by rail and canal) is as 4.375 to 1,000, a little over four and one-third in favor of canals, this is exclusive of tolls or profits. * * * We are led to the conclusion that in regard to the cost of construction and maintenance, and also in reference to the expense of conveyance at moderate velocities, canals

[1]The general rule already stated would give 2.36 mills.

are clearly the most advantageous means of communication, &c."

The velocity of movement does affect greatly the utility of the canal. The resistance increasing with the square of the velocity, for high speeds much greater power is required in these contracted channels, so that the practical limit for steamers on ship canals like the Suez, is found to be from five to six miles per hour. Velocity on a canal is equivalent to grade on a railroad, since it creates a hill or grade against the boat.

From the character of this evidence it will appear that even the early canals of small draught were cheaper modes of transportation than the railroads which were then charging about 2½ to 3 cents per ton per mile, and when Genl. H. Haupt, chief engineer of the Pennsylvania railroad, about 1854, proposed to reduce the rate to about one-half of this and increase the volume of the tonnage proportionately, it met with violent opposition from the board of directors, and was believed to be a ruinous policy. Now, however, the road is carrying a large portion of its enormous tonnage for less than one-half a cent, and making money.

But the time has evidently arrived when it will pay to enlarge some of the existing trunk line water ways to the dimensions of ship channels, especially where they form links in a water communication between populous communities. The enlargement of the Delaware and Raritan and the Delaware and Chesapeake are works which should no longer be delayed.

HISTORY

OF THE

NEW YORK PROPERTY TAX.